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ABSTRACT

Research has revealed that students' alertness and attentiveness are affected by time of day preferences. A review of relevant literature indicated that preferences are significant in predicting performance levels for school children, and that matching students with peak times is not only beneficial for academic subjects, but also influences discipline and test-taking. Teachers are also shown to have ideal times of day that may affect their teaching abilities. The purpose of this study was to find out how time of day affects student attention and achievement. Fifth-grade students (n=36) in a small, rural school in Virginia, were given Learning Styles Inventories (LSIs) in order to assess their personal preference for time of day. Then, they were taught and tested using scripted laser disk science lessons in both morning and afternoon situations. The goal of this project was to determine if students had high levels of attention and achievement when taught at times that coincided with their time of day preferences as indicated on LSIs. The results suggested that time of day played a role in student achievement. Students taught at times that matched their learning style preferences scored significantly higher on lesson-related quizzes. Students also scored better on average at their teacher's ideal time of day. The study also indicated that the majority of students can accurately predict their preferred time of day. The study illustrated that time of day should be considered as teachers plan and implement lessons. Appendixes include: science lesson-related quizzes; the morning/afternoon preference survey; learning styles inventory; and off-task seating charts. (Contains 24 references.) (ND)

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The Effects of Time of Day on Student Attention and Achievement

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Running Head: TIME OF DAY

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Abstract

Research has revealed that students' alertness and attentiveness are affected by time of day preferences. This discovery has led many researchers to take an in-depth look at this phenomenon. The purpose of this study was to find out how time of day affects student attention and achievement. Students were given Learning Styles Inventories (LSIs) in order to assess their personal preference for time of day. Then, they were taught and tested using scripted laser disk Science lessons in both morning and afternoon situations. The goal of this project was to determine if students had high levels of attention and achievement when taught at times that coincided with their time of day preferences as indicated on LSIs. The results suggested that time of day played a role in student achievement. The study illustrated that time of day should be considered as teachers plan and implement lessons.

The Effects of Time of Day on Student Attention and Achievement

The Problem

Teachers have always had opinions about the time of day when their classes perform best. Teacher discussions often center on the problem of motivating students to learn in the afternoon. During the fifth year teaching associateship experience in a small rural school in Virginia, two clinical instructors and three student teachers all believed that their classes did indeed perform better in the morning. This theory provided the basis for our investigation into how time of day affects student attention and achievement. In researching the literature, we noted that most current research theorizes that time of day affects students on an individual basis, not as a group. Because of this information, we revised our investigation to include personal preferences for time of day as related to learning. This study was designed to question the manner in which time of day affects students.

Need

If students were found to perform better at one particular time of day, there would be significant implications for school scheduling. Such a conclusion would warrant studies of the feasibility of alternative scheduling such as half-day schools or school schedules in which academics were concentrated at this peak time while other non-academic subjects could be taught at a time when alertness was not as high. If, on the other hand, as research indicates, time of day preferences are individual in nature, then every effort should be made to schedule students for academic classes at times when their alertness is at its peak level. If scheduling prevents such a possibility, however, then the idea of a rotating schedule in which the time for each academic subject changes each day would at least equalize the learning taking place in schools.

Teachers also can be affected by these peak times; therefore, attention should be given to accommodating for these differences. Is it fair for one class to consistently benefit from being instructed by a teacher who is most alert and enthusiastic in the morning while an afternoon class gets the same instruction but when the teacher is much less enthusiastic? If time of day does significantly affect students, then the present

educational system is not providing the very best education possible for all young people.

The Purpose

The purpose of this study is to investigate potential ways in which time of day affects education. There are six main questions to be answered by this study:

1. Is there a correspondence between students' self-reported preferred time of day on a simple time-related questionnaire and individual results of the Learning Styles Inventory, or LSI?
2. Is there a relationship between teachers' preferred time of day and students' scores on a series of Science lesson-related quizzes?
3. Do students score higher on Science lesson-related quizzes when they are taught and tested during their indicated preferred time of day?
4. Do students score lower on Science lesson-related quizzes when they are taught and tested at a time different from their indicated preferred time of day?
5. Are there increased attention-related problems when students are not taught at their preferred time of day?
6. Is there one time of day when all students score better on Science lesson-related quizzes?

Hypotheses

The answers to each of the above questions form the hypotheses of this research project. Research indicates that students are able to predict the time of day in which they perform best (Dunn, 1983). If students are able to predict their peak time, then the results of the Learning Styles Inventory and a simple time related questionnaire should show the same time preferences for each student on both indicators. If teachers are also affected by peak times, then they should in fact teach better when they are most alert. This result would be evident in higher scores by students taught during a teacher's preferred time of day. Research suggests that students perform best when taught at times that match their time of day preference; therefore, each student should perform better on Science lesson-related quizzes when taught and tested at times that matches his or her time of day preference as indicated on the LSI. Students should also perform significantly worse on Science lesson-related quizzes when they are taught and tested at times different from their preferences because of lower levels of alertness. Students who have significant levels of attention-related behavior problems should theoretically display these problems at the times when their learning style is not closely

matched. Under analysis, these behavior problems should occur most frequently for students who are mismatched for their preferred time of day. Finally, because time of day is an individual aspect of one's learning style, there should not be one time when all students score higher on Science lesson-related quizzes unless all students in this study share the same time of day preference.

Overview

The literature review for this study suggests that people have biological rhythms which affect their performance of tasks at different times of day. Researchers have also found that people have a unique way in which they learn best called an individual learning style. Additionally, studies suggest that students perform better and attitude is improved when students are matched with teaching styles that compliment this inherent learning style. Research also suggests that people can and do accurately predict their learning style. This study tests the idea of time of day as a component of the learning style.

Thirty-six fifth grade students were taught and observed during a series of laser disk Science lessons about the oceans in both a morning and an afternoon

teaching situation. Quiz scores, preference questionnaires and individual LSI reports were then collected and analyzed in order to answer the study hypotheses. Analysis of the results is followed by recommendations for future research in the area and applications for the current teaching situation.

Literature Review

Often people are quick to say whether they believe they are a morning person or a night owl. Sayings such as "the early bird catches the worm" promote these time of day preferences and are spoken by millions. Do time of day preferences really mean anything or are they merely myths passed down through the generations? Several researchers have taken these assertions seriously and decided to see if there truly is a time of day when people are most alert and ready for work. Many studies confirm that people do have peak times of day (Biggers, 1980, Dunn, 1985, Dunn et al, 1989). There is no one time when all people are most alert, though. These ideal times vary from person to person according to his or her biological makeup. Daily, or circadian, rhythms are affected by such biological functions as changes in body temperature and levels of testosterone or estrogen over the course of the day (Biggers, 1980, Mackenberg et al, 1974). Variations in alertness because of biological factors potentially have direct repercussions for all educators. If students have time-of-day preferences, then should schools try to ensure that each student is taught at his or her peak time? If there is proof that students and teachers have

significant variations in performance level throughout the course of a day, then methods of scheduling the school day can be questioned.

Circadian Rhythms

Biological data has emphasized specific times of day in which people are most alert. One of the first daily rhythms noted by scientists was the progressive rise in body temperature over the course of the day. Studies show that, for the majority of people, a low point is reached around 2:00 a.m., and a peak is reached in the middle of the afternoon followed by another gradual fall until bedtime (Biggers, 1980). Many researchers have related this body rhythm to job performance over the span of the day. Not all people have this particular type of temperature rhythm, though. Some people have temperatures that peak early in the morning followed by a decline and others have a delayed temperature pattern in which their temperature does not peak until early evening (Biggers, 1980). Biologists suggest that the peaks and slumps in temperature are related to task performance. If this is the case, school schedules do not benefit all students because not all students reach their peak times during the power morning hours in which most educators try to tackle the

most important and difficult subjects. Researchers also record a slump in temperature following lunch that most educators are quick to recognize, but little has been done in the area of school scheduling to accommodate this dead zone (Biggers, 1980). Researchers have shown that students can usually predict their physiological peaks using self-identification processes. One study used such a self-report method in order to show that students who indicated their alert time to be morning had significantly higher grades in school than students who peaked at other times in the day. In this particular study 56.3 percent of the students in the sample peaked at times other than morning (Biggers, 1980).

Another study was conducted to see if there were significant changes in the ability to do automatized tasks versus perceptual-restructuring tasks in male subjects from morning to afternoon. Simple repetitive tasks were shown to be performed better in the morning while perceptual-restructuring tasks were performed better in the afternoon. Researchers theorized that this change in ability was related to levels of testosterone in males throughout the day. Studies have shown that testosterone levels are positively related to performances of repetitive tasks and negatively related

to perceptual-restructuring tasks. Normally, testosterone levels in males are highest in the morning and then decline throughout the day (Biggers, 1980). While such information does not provide information for females it does promote the idea that biological factors can affect performance. Researchers suggest that functions such as temperature can apparently affect students throughout the school day and that particular biological rhythms such as testosterone level can have implications for specific types of learning.

The Learning Styles Inventory (LSI)

In 1974 Dunn, Dunn, and Price developed a self-report tool by which students could identify their own learning styles called the Learning Styles Inventory. The Learning Styles Inventory, or LSI, is a "self-report instrument based on a rank ordering of choices for each of 104 items for use with grades 3-12" (Dunn et al, 1981). The inventory is made up of true/false questions many of which are similar in nature to allow checking for a student's consistency in answering. Questions are geared to assess all of the learning style preferences mentioned in Dunn's definition of learning styles (1981). Twenty out of the one hundred four questions included in the inventory question time of day

preferences. The inventory went through six years of testing and revision in order to substantiate that it could validly and reliably identify grade 3-12 students' preferences in learning styles (Dunn and Dunn, 1979). Most investigators sited in this study used the LSI as a tool to identify learning styles because of its validity and reliability.

Learning Styles

Most of the research having to do with the way in which time of day affects students' achievement has been under the guise of matching students with their preferred learning styles. A learning style is defined as one of sixteen variables that affect the way in which a person learns.

> Learners are affected by their (a) environmental (sound, light, temperature, and the need for either a formal or informal design); (b) emotional (motivation, persistence, responsibility, and the need for either structure or options); (c) sociological (self, pair, peer, team, adult, or varied); (d) physical (perceptual strengths, need for intake, time of day or night energy levels,

and need for mobility) preferences (Dunn et al, 1981).

Educators have come to acknowledge that each student carries around a unique set of these preferences that define his or her optimal mode of learning. Traditionally, educational researchers have tried to ascertain the best method of education for all students. Now, research is moving toward focusing on individual students rather than one best method for all students. Advocates of learning styles theory ascertain that one type of learning format is not going to meet the needs of all students because each individual learns best through an educational approach that matches his or her unique learning style.

Some educators question the ability of students to identify their own best style for learning, but Rita Dunn, one of the leading advocates for learning styles-based education points out that "in testing more that 175,000 youngsters in grades 3-12, we find that most children not only *can* tell you how they learn, they *want* and are *delighted* that you asked (1983). Dunn does point out, however, that fifteen to twenty percent of students who do not have a significant change in levels of attentiveness during the day are unable to identify their peak times. This portion of the

population includes those students who are fortunate enough to learn equally well at all times of the day; therefore, their inability to identify this learning style does not hurt them (Dunn, 1985).

Many studies support the idea that students can in fact identify their preferred learning style. In a 1971 study, seventy-two college students showed that when questioned they could predict the learning style in which they would display their best performance (Dunn, 1983). Another study showed that students who had a preference in learning style scored better during testing on material taught in a way that complemented this preference rather than when mismatched for this style (Dunn, 1983). In another study conducted at the secondary school level, a significant correspondence was shown between matching students with a strong preference for a particular learning style with a teacher who implemented the style and high grade point averages. This study also showed that students who were mismatched in such a situation had significantly lower grade point averages (Dunn, 1983). Using a self-report inventory to identify learning style, Pizzo investigated the effect of both matching and mismatching students to their self-reported learning styles. He found that students matched with their self-reported learning style had

significantly higher reading scores than those students who were mismatched with their preference. All of these studies show that students are indeed able to identify the way in which they learn best if they have a strong preference, and that matching such preferences to instruction can increase academic achievement. Studies have also suggested that learning styles remain consistent throughout the lifespan so that by identifying a student's learning style early in schooling, the information can be used to help adapt teaching styles throughout a student's academic career (Sperry, 1973).

Many learning styles theorists believe that education is geared toward one type of student; one whose learning style best matches the traditional theory of teaching using mostly teacher-centered lecture, and rewards students who are auditory and adult-centered learners. Most of the research to date involving learning styles shows significant correspondence between matched learning style and performance in school (Dunn and Dunn, 1979). Educators who are against taking student learning styles into account when designing instruction may argue that many of the methods for learning promoted by learning styles theorists allow students to work independently or in small groups of

peers rather than a more typical teacher-centered approach. These opponents may worry about loss of teacher control in the classroom in such a situation. Dunn and Dunn argue that matching learning styles with teaching styles should help improve behavior in the classroom.

> It is precisely those students who are most difficult and who absorb most of our attention whose learning styles do not match the kind of instruction to which they are being exposed--and who most need the organized, sensitive matching of their learning characteristics with an appropriate teaching style (Dunn and Dunn, 1979).

Several studies report that matching teaching to learning style has significant effects in areas other than achievement. In a 1979 study, three hundred twenty-one students from grades three, six, and seven were administered both the Learning Styles Inventory and the How I See Myself self-concept scale. Significant differences between students with reported high and low self-concepts were shown with eight of the LSI variables. The study also showed a significant relationship between students who had high self-concepts and those whose learning styles were most closely

related to traditional schooling. Students with the highest self-concepts "prefer quiet, like to study in warm temperature, are adult and teacher-motivated, are persistent, prefer to learn in several ways, i.e., by self or with peers, do not have auditory preferences and do not need mobility." Students with low self-concepts "prefer to study or learn with sound (music or interaction of others), where it is cool, are neither adult nor teacher-motivated, are not persistent, prefer not to learn in varied ways, have auditory preferences, and need mobility" (Price et al, 1979). Such results imply that not matching a student's learning style affects not only achievement and grades, but also self-concept.

In another study, a teacher took twenty "worst" students at a Junior High School and implemented a curriculum that catered to the individual learning styles of the students. After implementation of the program academic performance improved, but more importantly for this particular group of students, their attitude toward school was also significantly improved. At the time of the study, no student had dropped out of the school and attendance was regular (Dunn, 1981). A principal in another school in which learning styles information was implemented noted that a young female

student who was a chronic truant changed from making F's to A's and soon began attending school regularly when teachers began to provide lessons that promoted her preference for tactual/kinesthetic learning (Cavanaugh, 1981). Such improvements in both achievement and attitude demonstrate the importance of taking learning styles into account when designing educational programs.

Preferred Time of Day As Related to Achievement

According to Dunn (1985), one-fifth of elementary school students are most alert in the early morning, one-third only after 10:00 to 10:30 a.m., and another one-third not until the afternoon. By the time students reach middle school, their ideal times are usually late morning or afternoon. For high school students peak times shift more to the extremes of early morning and late night. Many studies report this general trend in preferred time of day and the associated change with age, but there are significant differences in individual preferences for all age groups. While group averages are important to note, it is impossible to say that all students in one particular age group will learn best at one particular time of day.

Several researchers have suggested that the traditional school schedule favors students who are most

alert in the mornings (Dunn, 1979, Dunn and Dunn, 1979, Marcus, 1979, Price et al, 1981). In a study designed to test whether or not students with high reading achievement scores showed a preference for certain learning styles, preferred time of day was found to be one of the learning styles that did correspond to student achievement in reading. Those students with the highest reading achievement scores indicated a preference for learning other than the traditionally acknowledged morning power time. Students with lower scores showed a preference for late morning learning.

Several studies report that when students are matched with their preferred time of day they perform significantly better in school. In a study conducted by an elementary school in Suffolk County, New York, elementary students were placed in a two-year program for their math and reading classes in which they were matched with their peak time for one of the subjects and mismatched for the other each year. Students performed significantly better both years in the subjects that matched their preferred time of day (Bruno and Dunn, 1985). Other research goes so far as to suggest the best times of day for teaching specific subjects based on short and long term memory retention. Morton and Kreshner devised a study in which thirty-six normal,

learning disabled, and educable retarded children were assigned randomly to morning and afternoon sessions of a lesson calling for memorization. Both normal and learning impaired students were able to recall more information processed incidentally in the afternoon group (1985).

Time of Day and Other Student Behaviors

Time of day preferences can also affect other school issues such as discipline and standardized testing. In a study conducted by a New York principal, truancy was greatly reduced by assigning the truant population, the majority of whom, when tested, showed that early morning was their least energetic time of day, to classes after 10:00 a.m. (Dunn and Bruno, 1985). A principal in Greensboro, North Carolina used a learning style inventory which showed many different kinds of preferences among students (lighting, time of day, kinesthetic preferences, etc.) to implement a program to help boost standardized test scores. After studying the inventories, teachers decided to schedule subjects in order to teach at times when the majority of students were most alert. The most immediate outcome of the changes was a vast improvement in behavior. Test scores also steadily gained after the program was

implemented (Klavas, 1994). A principal in Hutchinson, Kansas also used time of day preferences to boost test scores. He assigned elementary school students to early morning, late morning, or afternoon sessions of a standardized test according to their peak times. Students showed significant gains in test scores when allowed to take the test at their preferred time (Dunn, 1985).

One study also suggested that teachers' peak times also influence their levels of attention. One group of teachers was placed in inservice workshops according to their time preferences while another group was purposefully mismatched. Those teachers whose time of day preferences were matched had significantly higher levels of implementation of the skills learned in the workshop than those who were mismatched (Dunn, 1985). One would have to question whether a teacher's peak times would also affect the learning of his or her students. If a teacher is more alert in the morning, then is it necessarily true that the afternoon subjects are taught with less enthusiasm and energy biasing students against them is some way?

Conclusions

All of these studies suggest that time of day

preferences are significant in predicting performance levels for school children. Studies further indicate that matching students with their peak times is not only beneficial for academic subjects, but also influences discipline and test-taking. Teachers are also shown to have ideal times of day that may affect their teaching abilities. All of this information points to the fact that all possible efforts should be made to match both teachers and students with learning during times of day in which they are most alert and ready to learn or teach.

Study Design

Sample

This study was conducted in a small, rural school in Virginia with a school population consisting of students in Prekindergarten through fifth grade. Class sizes range from seventeen to twenty and there were typically two or three classes at each grade level. The school drew its population from homes that were within walking distance of the school; therefore, only one bus was used to transport those students with special needs. The subjects of this study included thirty-six students from two classes in fifth grade. Two students receiving special education services participated in the lessons, but were not included in the data analysis. Most subjects in this study were of a low socioeconomic background, based on the fact that sixty-nine percent of the total school population received reduced or free lunches and the school also received Chapter I funds. One student out of the study sample was identified as academically gifted while all other subjects performed at or below grade level. Any student who was absent on one of the days and missed one of the two-parted lessons was excluded from that segment of the data analysis. Students were observed and tested for the relationship

between time of day and student attention and achievement.

Measures

Several measures were used to determine the best time of day for individual student learning:

-- Science laser disk lessons- For each of the two part weekly lessons, a two-part science lesson was chosen from a scripted laser disk series that was currently being utilized in the classroom. In order to assure consistency between the lessons taught by the student teacher in one class and the classroom teacher in the other class, the authors analyzed the scripted lesson to assess the places in which further explanation was warranted in order to ensure student understanding. These additional comments were then added into the script along with identical review questions for the teachers to use in both classes.

-- Quizzes- Following each lesson, students were given a written evaluation with twelve questions ranging in style from multiple choice to fill-in-the-blank to true or false. Quizzes were evaluated for similar difficulty in the level of questions for each quiz and all were found to be equal.

-- Dunn, Dunn and Price's Learning Styles Inventory- The inventory is made up of one hundred forty true or false questions that assess student's preferences for different types of learning. Twenty of the one hundred forty questions assessed student preferences for time of day. The authors along with both classroom teachers decided that excerpting a twenty-five question portion of the entire inventory was a better way of truly assessing student preferences since it was felt that students would be overburdened with the full-length inventory and, subsequently, not take it seriously. The inventory portion used for the questionnaire included time of day and intake questions. The intake questions were placed in the evaluation merely to draw attention away from the true emphasis of the questionnaire and were not used in the analysis of individual time of day preferences.

-- Morning/Afternoon Preference Survey- The students and teachers were given a survey in which they were asked to indicate their preference for learning/teaching science during scheduled morning times or scheduled afternoon times. Students were asked to think about the choice seriously and analyze when they thought they learned best.

--Off-Task Seating Chart- During each lesson an observer

in the classroom used a seating chart to monitor and record any behaviors that showed a student's lack of attention to the material. The off-task behaviors were then analyzed using a formula to assess percentage of off-task behavior. The seating chart was also used to watch for any students who were chronically distracted.

Design

The original hypothesis which spurred the development of the study was that all students performed better when taught in the morning because of higher levels of alertness. After initial discussion with the classroom teachers and a review of research, the hypotheses were revised to include a belief in time of day as an aspect of an individual's learning style. The study involved three two-day lessons. Laser disc lessons and follow-up quizzes were developed for all visits to the classrooms. Weekly visits took place on Wednesday afternoon and Thursday morning. Days in the middle of the week were purposefully chosen in order to alleviate extremes of attention recognized by most teachers on Fridays and Mondays.

Both classrooms were taught the same lesson. On Wednesday all students were taught in the afternoon from 1:45 to 2:15. Because of scheduling conflicts the

Thursday morning portions of lessons were taught at two different times in the morning. One class was taught from 10:45 to 11:15 while the other class was taught from 11:25 to 11:55. This difference should not have affected the data because classes were consistently taught at the same time each week; therefore, individual students were receiving instruction at the same time each week for purposes of this study. One class was taught entirely by the classroom teacher with student observers recording off-task behaviors while the other class was taught by a former student teacher with the classroom teacher recording behaviors. This difference was a scheduling necessity and should not have affected data because individual students were consistently taught by the same teacher.

The lessons were scripted and extra comments and questions were added prior to the lesson in order to ensure the closest similarity in both lessons. Both the student teacher and classroom teacher involved in the actual teaching discussed the script before each lesson as another means of ensuring consistency of instruction in both classes. Each lesson was followed by a twelve question quiz based on the information provided in the lesson. The same procedure was repeated on Thursday mornings using the second half of each two-part Science

lesson. Each portion of the two-part lesson was assessed and formulated to make it as similar as possible in order to alleviate lesson difficulty differences in quiz scores. During the last week of lessons, students were given a survey and asked to indicate their time of day preference as either during the morning Science time or the afternoon Science time. The next day students were asked to complete the twenty-five question portion of the Learning Styles Inventory.

The data collected during the experimentation portion of the study was used to formulate answers to the study hypotheses. The time of day preference survey and Learning Styles Inventory were analyzed to see if students indicated the same time of day as their most alert on both evaluations. The teachers' answers to the time of day survey were compared to both their morning and afternoon class quiz averages in order to assess whether student achievement was higher when the teacher was teaching at her preferred time. Averages were then calculated for students indicating preferences for morning, afternoon, and no preference according to the LSI. These averages were then compared to see if the groups did indeed score higher when taught at a time that matched their preference. Any student who seemed to have a chronic problem with attention was

individually analyzed using the off-task behavior formula in order to see if the problem occurred primarily during times other than that indicated on the Learning Styles Inventory. Individual student quiz averages for morning as opposed to afternoon lessons were analyzed to see if all students performed better at one particular time of day. After data analysis, recommendations were made as to how the results should affect education.

Analysis of Results

Each hypothesis was analyzed separately and then compared to all others in order to come to a conclusion about the significance of the data.

Hypothesis One

In order to compare the correspondence of students' individual time of day preferences on the Learning Styles Inventory and a time-related questionnaire, each student's self-reported time of day preference was matched with their indicated LSI preference. Percentage of students whose time of day preference matched their LSI preference were then compared to those students whose time of day preference did not match. Another percentage was calculated of students who showed no preference for one particular time of day on the LSI. It was found that 56.25% of students indicated the same time of day preference on both indicators and 25% of the group indicated conflicting evidence. Based on this analysis there was a definite correspondence between these two indicators. There were six students who had no time preference as indicated on the LSI. These cases were not included in the percentages because research has shown that students who have no time preference can

perform equally well at all times of the day (see figure 1).

Hypothesis Two

In order to test whether a teacher's time of day preference influenced class scores, class averages were made for both morning and afternoon lessons. It was then checked to see if the class average was significantly higher at the time of day preferred by the teacher. Each teacher had a strong afternoon preference. The results of a two-tailed T Test at the .05 level indicated that afternoon scores were significantly higher than morning scores in both classes (see figure 2).

Hypothesis Three

In order to test whether students scored significantly higher when taught and tested at their preferred time of day, students were first divided into groups based on their time preferences as indicated on the LSI (morning, afternoon, no preference). Twenty-four students were placed in the afternoon group, two students were placed in the morning group, and six students were placed in the group that had no preference. By comparison, those students in the

Time Survey vs. LSI

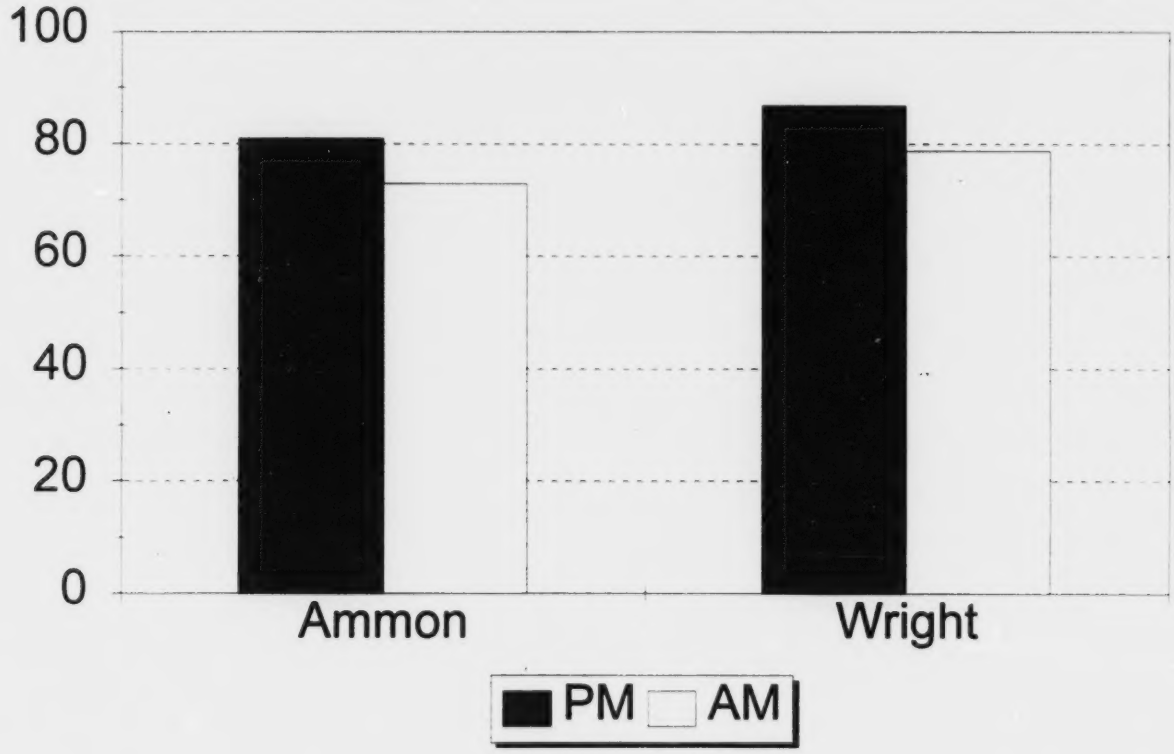
	A	B	C
1	Subject	Time Survey	LSI
2	1	A	aft
3	2	A	even
4	3	A	no pref
5	4	A	no pref
6	5	M	aft
7	6	M	ear morn
8	7	A	aft
9	8	A	no pref
10	9	A	aft
11	10	A	ear morn
12	11	A	even/aft
13	12	M	no pref
14	13	M	aft
15	14	M	aft
16	15	A	aft
17	16	A	no pref
18	17	A	aft
19	18	A	aft
20	19	A	aft
21	20	A	aft
22	21	A	late morn
23	22	A	even/aft
24	23	A	aft
25	24	A	even/aft
26	25	A	aft
27	26	A	aft
28	27	A	aft
29	28	A	aft
30	29	A	no pref
31	30	A	aft
32	31	M	aft
33	32	A	aft

56.25 % matched
18.75 no preference
25% no match

Figure 1

Figure 2

Score Averages For Both Classes



afternoon group scored significantly higher when taught and tested in the afternoon. Students who had no time preference had no significant difference in scores in the morning and in the afternoon. Students in the morning group scored significantly higher in the afternoon than in the morning. This result was found significant at the .05 level on a two-tailed T test (see figure 3).

Hypothesis Four

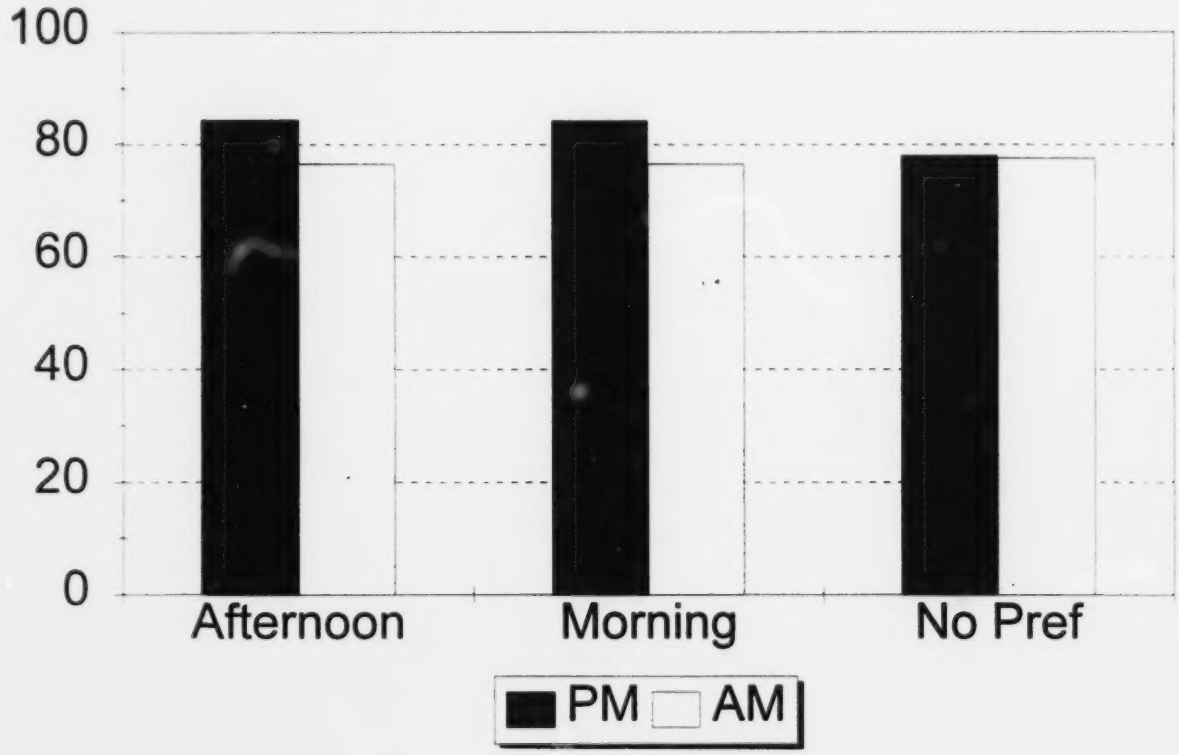
The same test was used to determine whether students scored significantly lower at times when they were not matched with their preferred time of day. The afternoon group scored significantly lower in the morning. The morning group scored significantly lower in the morning, and the students who showed no preference did not score significantly lower at either time. This result was also proven to a significance level of .05 (see figure 3).

Hypothesis Five

The incidence of attention-related behavior problems was analyzed in order to see if students who were mismatched for their preferred time of day had increased behavior problems. Individual cases in which

Figure 3

Average Score For Each LSI Groups



students had significantly more of these type problems were assessed using a percentage of off-task behavior formula. It was then checked to see if the percentage of off-task behavior correlated to times when the students were not matched for their preference. There were five students who showed a significant level of off-task behavior. Zero percent of these students had a higher rate of off task behavior when they were mismatched for their time of day preference (see figure 4).

Hypothesis Six

In order to determine whether there was one time of day when all students scored best, each student's average was determined for both afternoon and morning lessons. Then, this list was visually checked to see if all students had higher averages at one of these times. There was not one time when all students scored best (see figure 5).

Figure 4

Off-Task Behaviors

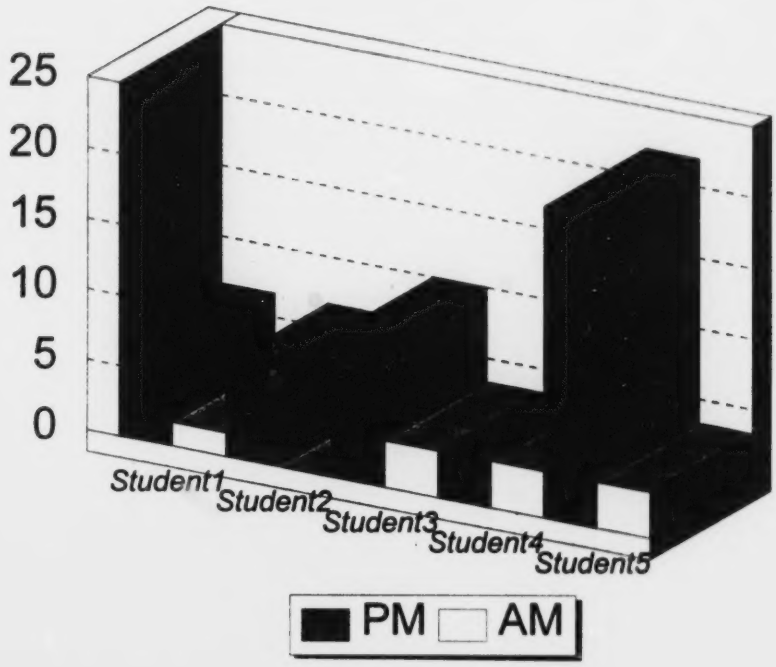
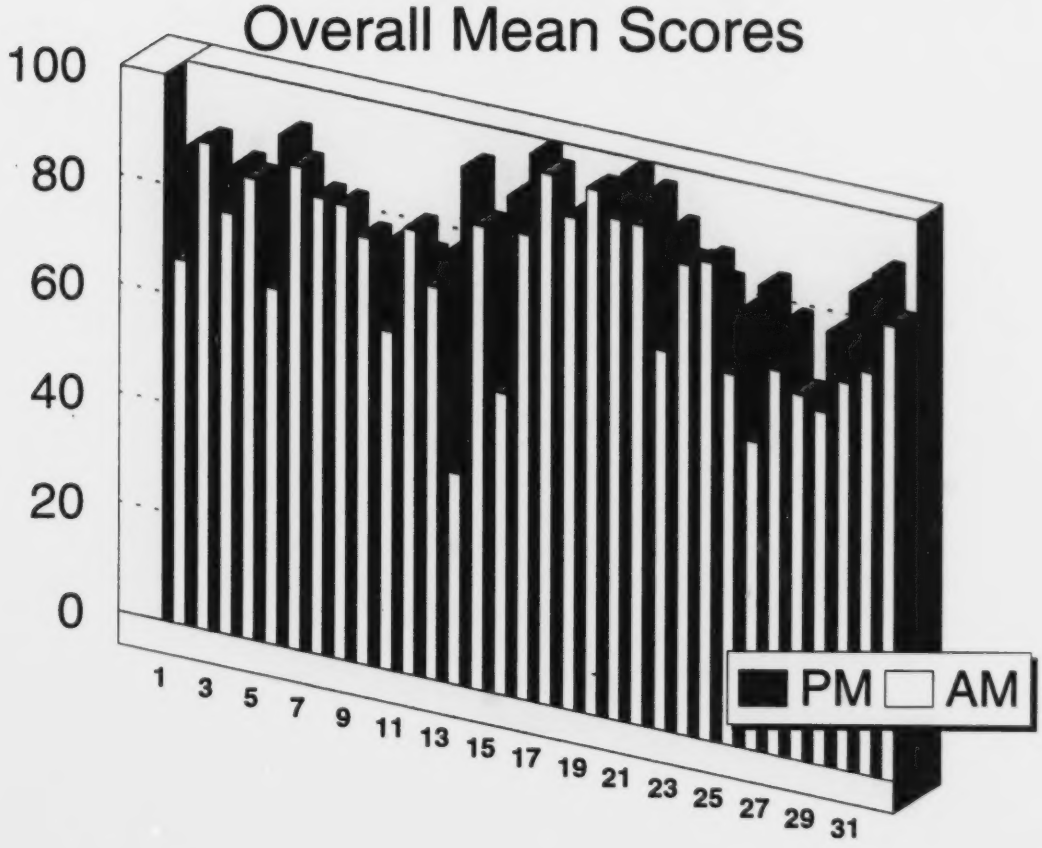


Figure 5


Overall Mean Scores
100
80
60
40
20
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31
PM
AM

Summary and Conclusions

Discussion of Results and Ideas for Future Research

The results of this study suggest that time of day plays a significant role in student attention and achievement. When the students in our study were taught at times that matched their learning style preferences, they scored significantly higher on lesson-related quizzes. This correlation was particularly strong in the case of students whose preferred time of learning was in the afternoon. This group made up the majority of our sample (twenty-four students). The morning group, which included only two students, also scored higher in the afternoon. Since only two students preferred the morning, it is unclear whether this finding is an error. The LSI also divides morning learners into early morning and late morning. In this study subjects were tested only in a late morning and afternoon setting. In order to draw further conclusions about how time of day affects morning learners, another study would have to be designed which included both early and late morning learning situations as well as more students whose LSI tests indicated a morning preference. The six students who showed no time of day preference on the LSI also had no one time of day when

they scored best. This finding matches the research on students who do not have a preferred time of day. These students are able to learn equally well at all times so there should not be one time of day when this group scores significantly higher. Both the afternoon group and the no preference group supported the study hypothesis under analysis.

One of the most significant findings of the study showed that students actually scored better on average at their teacher's ideal time of day. This factor suggests that teachers' time of day preferences do have some influence on student learning. Further studies in this area could be helpful in determining the reliability of this finding. If teachers do have an influence over their students in this manner, then teachers should be made aware of their individual time of day preferences. Awareness might allow teachers to counter their least alert times of day in order to provide a more balanced education for their students.

This study also indicates that the majority of students can accurately predict their preferred time of day. It was found that 56.25% of the students involved in the study indicated the same time of day preference on both the LSI and the time-related self-report questionnaire that we designed. There were six students

who did not have a time preference according to the LSI; therefore, their answers to the questionnaire were not considered valid. Students who do not have a time preference cannot pick a time when they learn best. It does seem that the LSI is a better indicator of time preferences than a simple questionnaire. This type of inventory is the best way for a teacher to determine strong preferences within his or her class because of the inventory's reliability and validity.

No real inference can be drawn relating student attention to time of day preferences; the authors feel that more research is needed in this area. Both of the classes used in this study are very well-behaved in general; therefore, the off-task behavior seating charts only indicated five students who could be analyzed for off-task behaviors. Such a small number naturally precludes any large generalizations about the manner in which time of day relates to student behavior. A future study could be focused on whether or not students identified as having high levels of attention-related behavior problems display the majority of these behaviors at times that do not match their learning styles preference.

The findings of this study indicate that time of day does impact student learning. Time of day effects

on students should be investigated as an individual factor affecting students rather than as a subset of students' learning styles. Educators have access to students for seven hours each day and scheduling should be used to accommodate these time of day preferences. Further research in this area should include larger samples, a longer time span,other grades, more tests including subjects other than Science, and early morning and evening times as well as the late morning and afternoon times used in this study.

Implications for Educators

Time of day has long been knows to affect all people. Educators have ignored this factor in scheduling the school day. Every effort should be made to schedule students to learn at the times when they are most biologically ready to learn. It is apparent that students are able to predict the times when they are most alert. We suggest that teachers who wish to implement learning style theory into their classrooms give the LSI to all of their students at the beginning of the year. This test could then be used to schedule students in their demanding classes at times when they are most alert. While it is impossible to fit all subjects into a student's preferred time of day, there

are some courses included in school that do not require as much total concentration (music, art, physical education) and could therefore be taught at a time that students are not at their most alert.

If scheduling students in class at their peak times proves impossible, the next best solution is to have teachers equalize the learning day so that all students have a chance to learn at times when they are most alert. A rotating schedule would provide such a solution. In such a schedule, classes would change times each day. On Monday, for example, students would study English first period, History second period, Spanish third period, Algebra fourth period, Physical Education fifth period, and Chemistry sixth period. On Tuesday, the same students would have History first period, Spanish second period, Algebra third period, Physical Education fourth period, Chemistry fifth period, and English sixth period. Students would have Spanish first period, Algebra second period, Physical Education third period, Chemistry fourth period, English fifth period, and History sixth period on Wednesday. The schedule would continuously rotate to enable the students to benefit from having each class during a time when they are at their peak levels of concentration and alertness. Such a schedule would work well in middle or

high school when students often have six different teachers throughout the day. Elementary teachers could implement a similar schedule within their classrooms simply by changing the times that they teach subjects each day. Too often it is found that in elementary classrooms reading is taught first thing in the morning every day followed by a routine schedule. While routine does help younger children in school, a teacher can set up a weekly schedule that varies teaching times for each subject during the week.

Time of day has been found to affect student learning. It is one of the few areas over which educators can exert a great deal of planning and individualization. Teachers and administrators should feel responsible for acknowledging and planning in a manner that alleviates the bias against students who do not learn best in the strictly set time schedule practiced in schools today. Educators are responsible for providing the best possible education for all students, and the best possible education is one that includes time of day as a factor in the learning process.

Appendix A: Science Lesson-Related Quizzes

Waves

Name: _____

1. Most waves are created by _____.

   a. rain b. wind c. lightning d. clouds

2. The highest place on a wave is called the _____.

   a. trough b. peak c. crest d. top

3. True or False. Waves are one of the most powerful forces of erosion.

4. Mark a trough on the above diagram of a wave with an "X".

5. Mark a crest on the above diagram of a wave with an "O".

6. How many crests are depicted in the above diagram? _____

7. How many troughs are depicted in the above diagram? _____

8. Any disturbance seen on the surface of the water is a(n) _____.

9. The _____ of a wave provides the force to move a surfboard.

   a. water b. energy c. weight d. shape

10. What shape does the water in a wave of a wave tank make? _____

11. True or False. The highest point of a wave is the trough.

12. True or False. In a wave the water moves in the shape of a triangle.

13. Does the water in a wave move with the wave in the middle of the ocean?

    How do you know? _____

_____

_____

14. Why did the Greeks and the South Americans view the ocean differently?

_____

_____

_____

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Waves 2

Name: _____

1. True or False. A breaker is any disturbance seen on the surface of the water.
2. A _____ creates a tsunami.
   a. volcano b. earthquake c. hurricane d. wind
3. What is another name for a tsunami? _____
4. True or False. In a tsunami the crest of the wave <u>always</u> reaches the shore first.
5. "Tsunami" is a _____ word.
   a. English b. French c. Chinese d. Japanese
6. In the _____ ocean earthquakes take place so often that a tsunami warning system has been put into place.
7. True or False. The best time to catch a wave is right before it breaks.
8. If the _____ of a tsunami reaches the shore first, sea animals and plants are left exposed.
9. Does water deep in the ocean travel in a circular path? _____
10. From the point of view of a wave, the shore curves _____.
    a. downward b. upward c. sideways d. none of the above
11. When it reaches the shore, the _____ can no longer keep its shape so it topples over.
12. When an earthquake takes place _____ (where), the movement of the land cause the water to move.
13. What is a tsunami? _____

_____

14. Why is a breaker formed near the shore rather than in the middle of the ocean? _____

_____

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Waves 3

Name: _____

1. Breaking waves release their energy on the _____.

2. Breakers _____ the rocky shore.

   a. build up b. erode c. have no effect on

3. What happens to the circular motion of water in a wave when it gets close to the shore?

   a. It expands and becomes a larger circle.
   b. It disappears.
   c. It flattens out because of contact with the ocean floor.

Each of the following conditions is most likely to occur on either a summer or winter beach. Mark an "S" beside the conditions most likely to occur in the summer. Mark an "W" beside the conditions most likely to occur in the winter.

_____ 4. Large, violent storms with large waves erode sand.

_____ 5. There is a gently sloping beach.

_____ 6. Sand is pulled onto the beach.

_____ 7. Sand is pulled out to sea.

_____ 8. The beach is very narrow.

_____ 9. Erosion is most likely to occur.

_____ 10. The beach is wide and sandy.

_____ 11. The beach has a very steep slope.

_____ 12. Sandbars are most likely to develop.

Tides

Name: _____

1. What has the most effect on the tides?

   a. the Earth b. the sun c. the moon

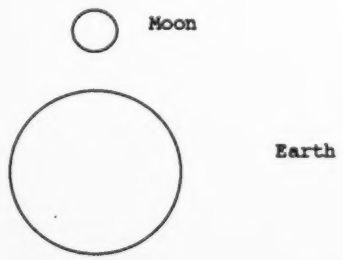
2. True or False. Tides occur only when there is a full moon.

3. How many high tides would occur in a 24 hour period (one day)?

   a. 4 b. 3 c. 2

4. A tide is _____.

   a. a dramatic change in water level
   b. a wave breaking on the shore
   c. a change in water temperature



5-8. Mark where all of the high tides would take place on the Earth with "H". Mark where all of the low tides would take place on the Earth with "L".

9. True or False. The amount of water in the ocean changes with the tides.

10. Which coast experiences two (2) full high tides and two (2) full low tides?

    a. Atlantic b. Pacific c. Gulf Coast

11. True or False. The sun has no effect on Earth's tides.

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Open Ocean and Shore Life 1

Name _____

1. Why do humpback whales travel long distances in the ocean?

   a. to find other whales
   b. to find food
   c. to move to warm water
   d. to reproduce

2. True or False. Humpback whales use their teeth to chew their food.

3. Where are the baleen located on humpback whales?

   a. above the eye
   b. on the back
   c. on the tail
   d. on the jaw

4. True or False. Humpback whales must come to the surface of the ocean to breathe.

5. True or False. Toothed whales are generally larger than baleen whales.

6. Squid belong to the same family as _____.

   a. clams b. whales c. fish d. dolphins

7. Large groups of fish are called _____.

   a. groups b. families c. classes d. schools

8. True or False. Dolphins are a type of whale.

9. What do humpback whales eat?

   a. fish b. sharks c. plankton d. fish

10. Plankton are _____.

    a. tiny plants
    b. tiny animal creatures
    c. tiny plant and animal creatures
    d. none of the above

11. The upward motion of cold water along coastal areas is called a(n) _____.

    a. uproaring b. upwelling c. uprooting d. fountain

12. What do toothed whales eat?

    a. squid and fish b. plankton c. seaweed d. coral

Open Ocean and Shore Life 2

Name _____

Choose a name from the following list of ocean animals to match the pictures presented on the television screen. Make sure to place the name in the correct number blank.

shrimp flounder sea whelk sea urchin starfish

clown fish mahogany quahog ray

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. True or False. All creatures can swim freely throughout many areas of the ocean.

10. True or False. Shrimp <u>usually</u> reproduce in protected areas along the shoreline.

11. A sea whelk has a special _____ that helps it drill through the shells of other mollusks it eats.

a. foot b. arm c. tongue d. tooth

12. Starfish use _____ to pry open certain shells.

a. tongue b. spines c. limbs d. head

Appendix B: Morning/Afternoon Preference Survey

Name _____

If you were given a choice between the following two times to have science lessons, which time would you pick? Think about this choice seriously. What time do you think that you are most awake and alert? What time do you think that you remember the most about your lessons? Place an "X" in front of the time that you would like to have your science lessons.

_____ 10:45 a.m.- 11:15 a.m.

_____ 1:45 p.m. - 2:15 p.m.

Name _____

If you were given a choice between the following two times to have science lessons, which time would you pick? Think about this choice seriously. What time do you think that you are most awake and alert? What time do you think that you remember the most about your lessons? Place an "X" in front of the time that you would like to have your science lessons.

_____ 11:25 a.m.- 11:55 a.m.

_____ 1:45 p.m. - 2:15 p.m.

Appendix C: Learning Styles Inventory (LSI)

Name: _____

		True	False
1.	I like to eat or drink, or chew while I study.	_____	_____
2.	I hate to get up in the morning.	_____	_____
3.	I dislike eating or drinking, or chewing while I study.	_____	_____
4.	I hate to go to sleep at night.	_____	_____
5.	While I'm studying I like to:		
	a. eat.	_____	_____
	b. drink.	_____	_____
	c. chew gum.	_____	_____
	d. nibble on snacks.	_____	_____
	e. suck on candy.	_____	_____
6.	I could sleep all morning.	_____	_____
7.	I like to go to school in the morning.	_____	_____
8.	I can eat, drink, or chew only after I finish studying.	_____	_____
9.	I usually start my homework after dinner.	_____	_____
10.	When I have homework to do, I like to get up early in the morning to do it.	_____	_____
11.	I usually eat or drink when I'm nervous or upset.	_____	_____
12.	I stay awake for a long time after I get into bed.	_____	_____
13.	If I stay up very late at night, I get too sleepy to remember anything.	_____	_____
14.	I hardly ever eat when I'm nervous or upset.	_____	_____
15.	I wish I could stay home during the day and go to school at night.	_____	_____
16.	When I can, I do my homework in the afternoon.	_____	_____
17.	I could study better if I could eat while I'm learning.	_____	_____
18.	I wish school would start near lunchtime.	_____	_____
19.	While I'm learning, eating something would distract me.	_____	_____
20.	I could stay up all night.	_____	_____
21.	I feel sleepy after lunch.	_____	_____
22.	I can remember things when I study them:		
	a. in the morning.	_____	_____
	b. at lunchtime.	_____	_____
	c. in the afternoon.	_____	_____
	d. before dinner.	_____	_____

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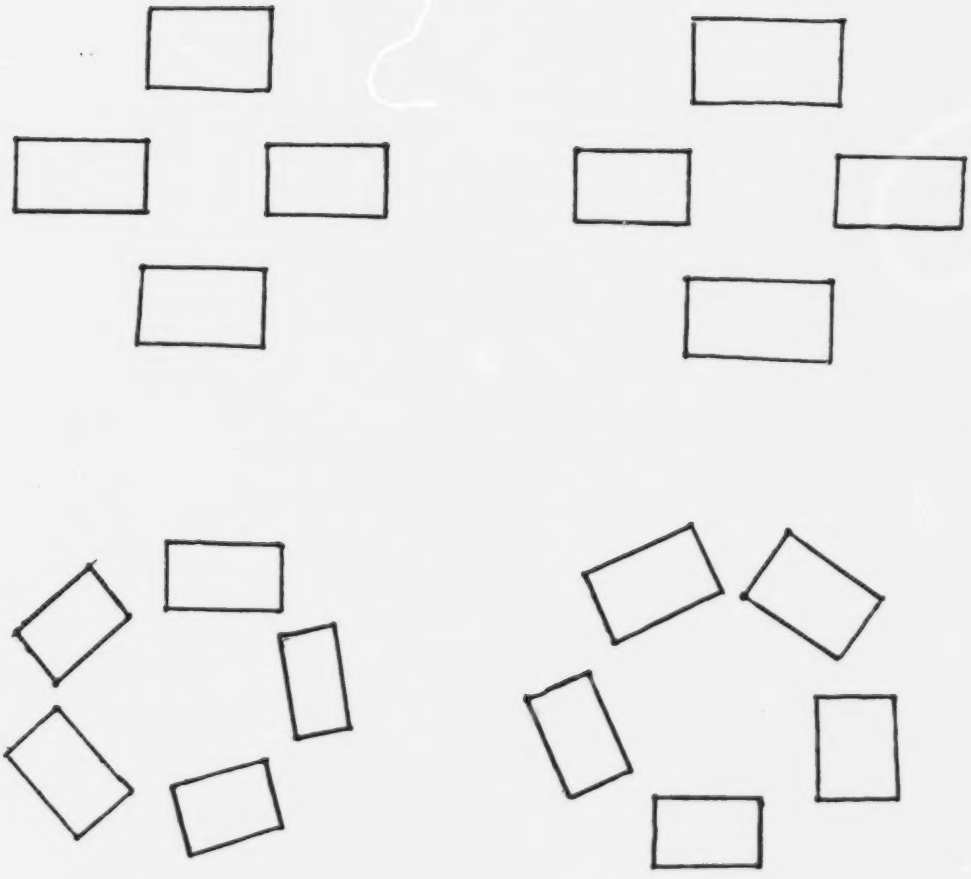
	e. after dinner.	_____	_____
	f. late at night.	_____	_____
23.	I often catch myself chewing on a pencil as I study.	_____	_____
24.	I feel wide awake after 10:00 in the morning.	_____	_____

Appendix D: Off-Task Seating Charts

TIME OF DAY
59

Blackboard



teacher desk

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